Appendix D: **Small Business Innovation Research Program (SBIR) FY 98 Topic Descriptions**

U.S. Army Natick Research, Development & Engineering Center (Natick)
Technology Focus Area: Lightweight Warrior Systems
The dismounted soldier is central to all land operations. In order to accomplish his mission effectively he must be able to move efficiently over variable terrain. The soldier is overloaded by the weight of the items he must carry. This weight presently approaches 200 pounds which is unacceptable as a combat load. In an effort to reduce the combat load of the soldier, the U.S. Army Natick RD&E Center has identified seven topics that focus on technology areas where improvements can be made to reduce the load carried by the soldier. The focus area, Lightweight Warrior Systems, includes a range of technologies related to the sustainment, survivability, and support of the soldier. Individual topics include textile technology for multi-functional uniforms and garments, including composite technology for body armor, electronically conductive garments, sustainment systems, and power sources. The topics presented have wide commercial application in addition to military relevance.

OSD98-001
Title: Light Weight Warrior Protective Enclosures
Technology: Textile Technology
Objective: To apply tubular textile technology to produce a seamless 1-2 soldier enclosure that will provide the warrior with improved protection, reduced weight and cube.
Description: Recent breakthroughs in textile manufacturing technology have demonstrated the ability to fabricate seamless tubular textile structures. This effort will transition emerging technology to the manufacture of a seamless shelter suitable for 1-2 soldiers. Seamless technology will result in faster production rates (reduced cost), reduced weight, reduced cube, and the elimination of water leakage associated with seams.

OSD98-002
Title: Multi-threat Protective Uniform System
Technology: Multi-functional Textile Materials, Uniform Systems
Objective: To combine emerging material and system design/manufacturing technologies to develop a multi-layer, mission tailorable uniform system with the capabilities and protection necessary to address the environmental, chemical, flame/thermal, electrostatic, POL, and signature detection hazards that may be encountered on the battlefield of the 21st century across a broad temperature range at a 20 percent reduction in weight and bulk over current clothing items.
Description: The military has historically developed clothing items to defeat individual battlefield threats, e.g., cold weather clothing system, separate from a flame resistant uniform system. This results in a soldier requiring many layers of clothing, each providing a specific protection, which is also very heavy and bulky and inhibits soldier combat effectiveness. This effort should characterize the behavior and performance of a system by determining the cumulative effect of state-of-the-art/emerging material technologies on flame/thermal protection, environmental protection, and heat stress when combined at the uniform system level, and assessing the impact on the warrior performance.

OSD98-003
Title: Electro Optic Fabric Concepts for Combat Clothing
Technology: Microelectronics, conductive textile materials, fiber optics, and micro sensors
Objective: Integrate a conductive electronic/optical network within prototype garments constructed from wearable fabric.
Description: The first step in integrating microelectronics into the soldier system is to develop a wearable electronic network. The network will support sensor/monitor and actuator attachments and interconnections fed by a computer processor and transmitter. This effort will develop conductive network materials, sensor attachment techniques, and textile seaming methods and will result in the fabrication of prototype(s) ECG for proof of concept. The network may ultimately support a variety of environmental or chemical sensors, may provide for an active two way antenna system for transmitting and receiving voice/data information, or may supply power from a central battery to sensors remotely mounted to the soldier's extremities. Future alert detection systems may also require interconnection to a computer processor to signal the soldier of the presence of a mine, the enemy, chemical/biological agents, etc. [Note: Technologies developed may also be applicable to tentage and airdrop fabrics].

OSD98-004
Title: Elastomeric Perm-Selective Materials for Chemical Biological (CB) Protective Clothing.
Technology: Membrane Textile Technology
Objective: To develop, demonstrate, and transition elastomeric, selectively permeable materials that will serve as a foundation for one-size-fits-all garments.
Description: Chemically-resistant, waterproof, and breathable polymeric materials with unusually high stretch-and-recoverable ratio and low creeping behavior will be developed for use in the development of a new generation of CB protective clothing and closure systems. This will eliminate the need for overgarment, undergarment, and multiple garment sizes thereby reducing costs, weight, and logistic concerns and problems that soldiers currently face. Selecting a "right" polymeric material that has properties and characteristics as mentioned above has been identified as a major challenge in developing a closure system for CB protective clothing.

OSD98-005
Title: Pocket-stove
Technology: Combustion
Objective: To develop a pocket sized stove that will burn logistics fuels (diesel and JP8) to provide hot water for dehydrated rations, beverages (coffee and cocoa) and limited personal hygiene, and provide basic technology for small heat driven devices including, personnel warmers, heat driven coolers (microclimate and beverages), lanterns, thermophotovoltaic generators, and infrared markers.
Description: Soldiers have no acceptable method for heating water. Trioxane fuel bars have historical supply problems. Commercial camp stoves (8-10K BTU/hour) are too large and heavy for infantry, and none will burn diesel fuel. Accordingly, new approaches and new technology must be explored that will enable a pocket sized stove with an output of 1-2K BTU/hour weighing not more than 4 ounces (2 ounces desired), that connects to a standard fuel bottle (i.e., commercial), that can heat 16 ounces of water in a canteen cup to 100˚F in less than ten minutes, and that will cleanly and safely burn diesel and JP8.

OSD98-006
Title: Evaluation Environment for Light Weight, Low Power Concepts
Technology: Engineering Modeling, Simulation, Computer Aided Design
Objective: To investigate and develop a prototype Virtual Evaluation Environment to support engineering level assessment/exploration of individual protective clothing, shelter, and nutritional items in high fidelity simulated settings that accurately recreate actual use environments.
Description: During the envisioned effort an end-to-end virtual evaluation environment will be created that supports exploration of proposed new, changed, or enhanced individual clothing and equipment, food, shelters, and ground mobility items. In this environment the available fidelity will support: 1) examination of the effects resulting from small changes in item characteristics; 2) rapid execution of numerous simulation iterations for each set of variable pairings to establish statistical significance of proposed changes; 3) parametric analysis of potential item characteristic changes; and 4) examination of the relationship between item characteristic changes and changes in human behavior, performance, quality of life, and survivability.

OSD98-007
Title: Polymer Electrolyte Batteries
Technology: Polymer Science, Electrochemistry
Objective: To develop rechargeable polymer batteries with high specific energies and specific power, based on polymer electrolytes synthesized by enzyme catalyzed reactions.
Description: Future rechargeable batteries for the individual soldier require high specific energies (>150 Wh/kg) and high specific power (>40 W/kg) over a temperature range of -400 C to +700 C. Batteries based on polymer electrolytes have advantages over existing power sources for this application. To meet the above requirements, polymer-based electrolytes require: a) high conductivity at the ambient temperatures, b) good physical and thermal stability, c) chemical compatibility with electrode materials, and d) high recharging efficiency. Conductivity of solvent-free polymer electrolytes presently known are too low at ambient temperatures to be useful. The highest conductivity achieved to date is ~10-5 S/cm at room temperature. Hence, there is a need to develop polymer electrolytes with significantly higher conductivity and stability than the present generation materials, and develop batteries from these polymer electrolytes. It is necessary to pursue unusual approaches in order to develop polymer electrolytes having conductivity of the order of 10-3 S cm- 1. Studies carried out at Natick with enzyme-catalyzed reactions have indicated that tailored polyaromatic compounds may be synthesized with functional groups (such as carboxylic and sulfonic groups) with well defined molecular weight and dispersity. Polymers synthesized from functionalized monomers are expected to have high conductivity, with good thermal, physical and chemical stability.

U.S. Air Force Defense Air Reconnaisance Office (DARO), Advanced Development Division (ADD) /Wright Laboratory
Technology Focus Area: Airborne Remote Sensing
The following SBIR topics support both commercial and military applications for airborne (and spaceborne) remote sensing.

OSD98-008
Title: High Data Rate Solid State Storage of Data
Technology: Airborne Remote Sensing
Objective: The next generation reconnaissance sensors will exceed the capability of current data storage devices. What is needed, is a high data throughput, low bit error rate (BER), digital storage device capable of operating in an airborne environment.

Description: Advancements in military and commercial sensors have resulted in airborne, space, ground and water based systems that collect a tremendous volume of high-resolution imagery. To date, mechanical recording systems have been used to store and disseminate this data. The amount of data to be collected in the future from a single sensor platform, however, is anticipated to exceed the capability of current and projected mechanical storage systems. In addition, mechanical systems are prone to poor reliability and other system errors (hardware/software, communications errors, processing errors, etc.). Fortunately, recent advances in solid state memory modules could meet the anticipated data storage needs. No work, however, is being done in applying these high density solid state memory modules to airborne data storage devices. The offeror should, therefore, address the requirements, development, and demonstration of a solid state memory system capable of meeting the data storage requirements. The proposed system should be capable of storing 500 Gbps - 1,500 Gbps with an I/O of 3 - 10 Gbps with a maximum Bit Error Rate 1E-14. The system shall be highly reliable, maintainable, power consumption less than 100W, and packaged to fit within a volume of less than 1.5 cubic feet.

OSD98-009
Title: Investigate Using Network Protocols on Asymmetric RF Datalinks.
Technology: Airborne Remote Sensing
Objective: To perform computer simulation and modeling of performance of transmitting/receiving ATM cells through an asymmetric Department of Defense airborne RF data link called the Common Data Link.
Description: The DoD Common Data Link is an asymmetric wideband X or Ku-band RF data link used for airborne-to-ground and airborne-to-airborne data applications. The data link may have 10.7, 137, or 274 megabit/s downlink data rates, but only 5 to 200 kilobit/s uplink rates. The DARO is interested in characterizing the performance and effects of using ATM network protocols with an asymmetric data link such as CDL, to transmit and receive MPEG compressed video, still imagery, or other products in an environment where the bit error rate (BER) could range from 10e-3 to 10e-12, with NSA crypto devices and forward error correction in the data link, with or without jamming.

OSD98-010
Title: Phased Array Antennas
Technology: Airborne Remote Sensing
Objective: To investigate feasibility of/performance characteristics for Unmanned Aerial Vehicles, manned aircraft, etc., operating with LEO or HEO satellite constellations for air-SATCOM wideband RF data links.
Description: DARO is interested in operating low (10,000 feet) to high altitude (65,000 feet) airborne systems with low earth orbit, medium earth orbit, or high earth orbit communications satellites to reduce size, weight, power, and aperture requirements on the airborne vehicles vice operating with geo-synchronous orbit satellites. Small aperture, twin-beam, steerable, full duplex conformal phased array antennas are an enabling technology to maintain continuous communications with satellites as they orbit above and disappear over the horizon. The hypothesis is that with a twin beam phased array, the air vehicle could electronically switch from communicating with one satellite to the next without a lapse in communications, and without exceeding size, weight, or power constraints. DARO desires to investigate the feasibility of this technology in the 11 GHz to 40 GHz RF spectrum, operating at 2 megabit/s to 600 megabit/s data rates. DARO specifically desires to investigate the possibility of using this antenna technology with future planned systems.

OSD98-011
Title: Small Size, Multifrequency, Multibeam Phased Array Antenna Systems
Technology: Airborne Remote Sensing
Objective: To determine the technical feasibility of using multi-frequency, multibeam full duplex phased array antennas to allow a ground control station to simultaneously receive and transmit data with up to 2, 3, or 4 airborne systems, such as Unmanned Aerial Vehicles.
Description: DARO is developing or already has in the inventory, systems using C, X, or Ku-band RF data links. Each flying system has an associated unique ground station. DARO desires to investigate the possibility of using a single ground station transmitter to simultaneously send to and receive from multiple airborne systems to reduce ground station footprint, uniqueness, and the requirement for a one-to-one correlation between the airborne system and ground system. Data rates vary from 1.544 megabits/s to 274 megabits/s downlink rates, 64 kilobits/s to 10.7 megabits/s uplink rates. Small physical size suitable for tactical use is desired.

OSD98-012
Title: Advanced Compact Antenna Technology
Technology: Airborne Remote Sensing
Objective: To demonstrate enhanced antenna element gain for small lightweight synthesized virtual antennas to achieve greater performance than the physical antenna element would allow. The goal is to achieve improved signal-to-noise performance in weak and/or adjacent/co-channel interference environments with very compact antennas.
Description: Develop a mathematical model to support the improved performance of a multi-element synthesized virtual antenna. Develop a single prototype element and a prototype synthesized virtual antenna system. Demonstrate the synthesized virtual antenna capabilities for a small lightweight airborne antenna application.

OSD98-013
Title: Object-Level Change Detection
Technology: Airborne Remote Sensing
Objective: To demonstrate processing techniques to determine changes in the presence or position of objects in a scene, while ignoring changes in local or overall scene illumination.
Description: Simple change detection algorithms for imagery may operate by detecting changes in illumination of images. These techniques suffer from false alarms due to differences in illumination conditions between the two frames being compared. Object-level change detection algorithms are based on the ability of the processing to segment an image into areas corresponding to distinct objects. Changes in the status of objects are then detected, due to movement of objects into or out of a scene or within the scene. In addition to the benefits of increased false-alarm immunity, object-level change detection allows a degree of machine understanding of the changes. For example, disappearance of an object in one location and appearance of a similar object in a new location could indicate object movement.

OSD98-014
Title: Optimized Data Compression for Hyperspectral Imaging
Technology: Airborne Remote Sensing
Objective: To develop a lossless compression algorithm that utilizes redundant information both spatially and spectrally.
Description: Hyperspectral imagers can now be procured that are both reliable and fairly inexpensive. This technology availability is fostering a revolution in the military and commercial remote sensing community. The biggest hurdle, however, is the

volume of data obtained with one of these instruments. Recording or downlinking the raw data is often prohibitively expensive. For many applications, degrading the data by applying a lossy compression, invalidates the results. The desired algorithm should determine the maximum lossless compression possible given the spectral/spatial hypercube and efficiently compress the data. If an asymmetric encoding/decoding scheme is utilized, it would be preferable to have the majority of the computation in the encoding.

OSD98-015
Title: Flexible Hyperspectral Dispersive Elements
Technology: Airborne Remote Sensing
Objective: To develop a flexible bandwidth spectral dispersive element.
Description: Exploitation of hyperspectral imagery is currently hampered by the volume of data collected. Current methods detect entire spectrum. However, only certain regions of the spectral information are needed. In fact, most schemes need narrow bands in some regions and only coarse resolution in others. This proposal is to enable the technology for producing low cost custom-design spectral dispersive elements with flexible band centers and bandwidths.

OSD98-016
Title: Optical Field Flatteners for IR Hyperspectral Sensors
Technology: Airborne Remote Sensing
Objective: To produce a high-quality, low cost field flattener for infrared hyperspectral sensors.
Description: The dispersion elements for hyperspectral sensors separate the spectrum in angle. Focal planes, however, are 2-D detectors with pixels of constant dimensions. These attributes force a trade between preserving spectral bandwidth constancy and having a wide field-of-view (FOV) system. Conventional glass field flatteners cannot accommodate the larger field curvatures. This effort will concentrate on using IR optical fibers to provide the necessary field flatness.

U.S. Navy Theater Air Defense PEO - Naval Surface Warfare Center, Dahlgren Division
Technology Focus Area: Modeling and Simulation
The following topics support the commercialization of advanced systems of systems modeling and simulation methods and tools for both DoD and the private sector.

OSD98-017
Title: Information Flow Analysis Capability
Technology: Modeling and Simulation
Objective: To develop information flow analysis capability to define, chart, analyze, and visualize the information elements flowing among a set of objects (platforms, systems, human decision makers) in a complex-adaptive theater warfare system.
Description: A military theater of operation is a complex, dynamic, system of interacting objects constantly adapting to changes in the theater environment. These adaptations are based on the various objects in the theater system acquiring information about the environment, identifying patterns in that information, defining action models based on those patterns, and making decisions to act in some manner on the basis of those models. This process occurs with the human decision makers throughout a chain of command as well as the systems those decision makers use to support their actions. Understanding the information flow and the interactions of information elements within this complex and ever-changing environment is critical to being able to conceptualize and design theater systems and processes.

OSD98-018
Title: Visualization of the Effects of Architectural Failure for Large-Scale High Assurance Systems
Technology: Modeling and Simulation
Objective: To provide engineers with tools which will aid the early understanding of how large, complex systems can fail.
Description: It has been known for years that the earlier that errors in requirements (also design and implementation) are discovered, the less costly they are to fix. By integrating failure analysis tools with modeling and simulation tools which provide for visualization of behavior, the goal of early recognition of requirements and design errors can be realized. The result of this effort will help fully integrate failure analysis into the system development process, thus aiding the understanding of the behavior of large, complex systems when subsystems fail.

OSD98-019
Title: Human Engineering Tools for Engineering of Complex Systems
Technology: Modeling and Simulation
Objective: To develop an integrated set of performance prediction, performance evaluation, workload assessment, and decision support tools for assessing the human engineering aspects of U.S. Navy and commercial system designs within a "systems engineering" (SE) framework. This tool set will be used to evaluate reduced manning and automation concepts for new and evolving large-scale designs.
Description: The Navy needs tools to plan for, design, and evaluate alternative manning and automation concepts (with the goal of reducing crew sizes) prior to implementing specific technologies and designs. While there are a number of tools currently available that can provide designers and analysts with assistance in evaluating these issues, the currently available tools fall short in several key areas. 1) Available tools are not specifically applicable to human system integration issues associated with shipboard manning and the unique team requirements and associated workload issues. 2) Those tools that do exist are designed more for post-design analysis, versus engineering the human operator into the design at the outset. 3) Human engineering considerations of the operator as an integral "system" component are not yet supported in any systems engineering tool sets. An integrated tool set that can perform some set of the following functions will greatly augment current system modeling and analysis capability: a) capture and articulate engineering requirements specific to the human operator, b) weigh the costs and benefits of human operators against automation, c) create candidate display concepts (based upon human factors principles), d) provide performance modeling, and e) perform individual and team workload analyses (including cognitive, perceptual, and motor workload). This integrated tool set must be compatible with existing databases of shipboard tasks and performance elements. Additionally, it must be capable of interacting with typical system engineering models. This set of analytical tools for evaluating automation alternatives in quantitative, unambiguous terms would predict which alternatives would be most likely to result in successfully reducing manning within the domain of safe and effective shipboard operations. These tools are needed to address the allocation of functions and tasks to humans and to advanced technologies, evaluate the design of workstations, interfaces, jobs and procedures, as well as identify additional training requirements resulting from the introduction of new technologies.

OSD98-020
Title: Virtual Prototyping Environments for the Development of Systems of Systems.
Technology: Modeling and Simulation
Objective: To develop an integrated engineering environment which provides new capabilities to enable the prediction and evaluation of total system performance as well

as system design trade-offs. Apply modeling and simulations, synthetic environment, and virtual reality technology to the implementation of virtual prototyping capabilities for the design, manufacture and test of systems of systems.
Description: Virtual Reality (VR) technology is advancing and maturing very quickly. VR technology is now being invested in and applied in many fields such as engineering, manufacturing, chemistry, aerospace, and medicine. The two greatest benefits of this technology have been significant reduction of cost and development time in these engineering disciplines. However, VR has not been substantially utilized in the area of system engineering. Because system engineering deals with large, complex, real-time systems of systems, the greatest benefits are in cost reduction in the system development process. This effort will develop and apply VR technology in concert with system modeling and analysis tools for application to integrated system engineering environments to enable virtual prototyping, virtual manufacturing, and virtual testing of candidate large-scale system designs. The following capabilities are critical in supporting virtual engineering environments: a) generic infrastructure and system engineering life-cycle support for large scale real-time systems; b) distributed simulation support for integrated battlespace engineering and analysis; c) resource optimization for large scale information systems; d) wide area collaborative system engineering; and e) configuration management for distributed large, complex, real-time federated systems architectures.

Naval Air Warfare Center, Patuxent River
Technology Focus Area: Health Monitoring of Navy Aircraft
The following topics will be considered for award:

OSD98-021
Title: Distributed Crack Initiation and Growth Monitoring System
Objective: To develop a Distributed Acoustic Emissions (AE) monitoring system for the detection of cracks in metallic structural components using advanced sensor techniques such as fiber optic sensors. The main requirements of this system is that all the sensors will be powered and interrogated with a single line such as a single optical fiber or a single coaxial cable. The system will be sensitive to frequencies in the 100KHz to 1 MHz band and it will detect the AE events in the presence of quasi-static loading. The loading state will also be determined using the same sensor system.
Description: A system for reliably detecting cracks in aging aircraft structures and in next generation fighters is critically needed. AE monitoring is the only proven method of detecting cracks in metals without having to place the sensor directly in top of the cracks. However, present AE monitoring systems suffer from various limitations. Each sensor needs two wire leads to pick up the signal, the wire leads have to be heavily shielded to avoid EMI, each sensor needs a pre-amplifier and signal conditioner nearby; two more wire leads are required for each amplifier. Techniques that use fiber optic Bragg gratings offer the opportunity of solving all these limitations. A single optical fiber will have embedded in it various Bragg grating sensors, all sensors will be interrogated using a single laser beam, and since there is no attenuation in the fiber there will be no need for pre-amplifiers or signal conditioners. Also, the system does not require EMI shielding since it is optical in nature.

OSD98-022
Title: Distributed Corrosion Monitoring System
Objective: To develop a distributed Corrosion Monitoring system capable of detecting the occurrence of corrosion in key structural components and monitoring its evolution and severity.
Description: It is well known that stress-corrosion cracking and corrosion fatigue can significantly reduce the life expectancy of structures. Therefore, it is critical to develop

a monitoring system which can reliably and accurately detect the amount of corrosion experienced by a structure. In this way early and economic repairs can be performed to the structure at the same time that the useful life of the structure is extended. System concepts should be capable of detecting and monitoring the evolution of corrosion in hidden aircraft structural components such as inside lap joints, around fasteners and under aircraft skins.

OSD98-023
Title: Distributed Adhesive Bond Monitoring System
Objective: To develop a distributed health monitoring system capable of monitoring the integrity of adhesively bonded structures.
Description: The cost associated with periodic inspection of aircraft structures is astronomical. This cost will continue to rise as our fleet ages further with no new replacements for the short term. A health monitoring system could significantly reduce the cost of ownership by reducing or eliminating periodic inspections and replacing them with on demand inspections. Also the reliability of detection would be increased because the damage location could be triangulated beforehand. The inspection time would be reduced because only the damaged site would be inspected and repaired.

OSD98-024
Title: Health Monitoring of Rotating Engine Parts
Objective: To develop a distributed health monitoring system capable of monitoring the integrity of moving engine parts. The sensor system will be permanently installed in the engine and will have to be compatible with the engine environment.
Description: The cost associated with periodic inspection of aircraft engines is astronomical. This cost will continue to rise as our fleet ages further with no new replacements for the short term. A health monitoring system could significantly reduce the cost of ownership by reducing or eliminating periodic inspections and replacing them with on demand inspections. Also the reliability of detection would be increased because the damage location could be triangulated beforehand. The inspection time would be reduced because only the damaged site would be inspected and repaired.

United States Special Operations Command (USSOCOM) Topics
Technology Focus Areas: Special Operations Biomedical; Sensors & Information Technology; and Materials Technology.

Technology Focus Area: Biomedical
OSD98-025
Title: Casualty Retrieval Device
Objective: To develop a casualty retrieval device for safer retrieval and extraction of battlefield casualties.
Description: Casualty retrieval is a high-risk operation, and will be even more so in the future characterized by increased operations in urban terrain. Studies show that 10% of battlefield injuries are received while attempting to render aid to other casualties. The purpose of this effort is to develop a casualty retrieval device for ground forces. The item would allow casualty retrieval from a safe location and distance. One concept could be a munition deployed net. The item should have the following objective characteristics:

a. Single or multiple use (i.e., reusable);

b. Lightweight - Less than 1kg for a single use device. Less than 2 kg for a multi-use device;

c. Capable of engaging and retrieving a casualty and his/her load bearing equipment weighing less than or equal to 120 Kg over a distance of 25 meters. It would be desirable for this device to also work when the casualty is in the water, and for this

device to be capable of lifting the entire weight of the casualty (with gear) vertically (i.e. up walls, ravines, etc.);

d. Reliability, durability, and affordability will be additional considerations.

Technology Focus Area: Sensors & Information Technology

OSD98-026

Title: Electronically Scanned Phased Array Antenna (ESA)

Objective: To develop a low cost and lightweight ESA for rotary wing and tilt-rotor aircraft.

Description: It would be highly desirable for military aircraft to utilize low-power radar when operating in all-weather conditions and low altitudes. The problem with this class of radar is that it requires a large antenna to receive an acceptable return to conduct operations. While such an antenna is acceptable for fixed wing aircraft, it is not for rotary and tilt-rotor aircraft because of on-board size and weight constraints. An antenna that is both small enough to fit aboard rotary and tilt-rotor aircraft, and large enough to facilitate the necessary return is not currently available. Electronically scanned antenna (ESA) technology could provide the solution to this requirement. The intent of this project is to develop a lightweight, low cost ESA that will allow incorporation of low-power coherent type radar systems on-board rotary and tilt-rotor aircraft, and at the same time significantly decrease the support cost for radar systems on-board rotary aircraft.

OSD98-027

Title: Stand-Off Tag Emplacement

Objective: To develop the ability to place tracking devices on objects and individuals remotely.

Description: While tagging and tracking technologies are progressing for both military and commercial purposes, the ability to affix or emplace tags remotely has not been addressed. There is a need for the capability to emplace tagging/tracking devices remotely and clandestinely, which would be useful in secure, hazardous, or denied environments. The purpose of this SBIR effort would be to develop tag emplacement concepts and associated equipment. The optimum emplacement concept will probably limit and might define the tagging/tracking technologies that can be utilized, so a systems level approach to development and testing must be used. A system is desired that can be employed (i.e., emplaced and monitored) to track high value assets inside buildings and outdoors, and in all types of weather and terrain, while allowing operators to remain safe distances away.

Technology Focus Area: Computing and Software

OSD98-028

Title: Database Conversion Software

Objective: To develop a process which converts native format databases to other formats with little or no loss of resolution.

Description: Special Operations Forces use a variety of mission planning and mission rehearsal tools which depend on imagery based or partially imagery based terrain databases to provide a 3D visualization of the environment in which the mission is to be carried out. There are several database generation facilities that provide products. Some facilities are USSOCOM activities. However, there are other facilities that are not controlled by USSOCOM, which provide products in different formats. The conversion of databases from one format to another currently requires separate converters for each format. Our requirement is that industry provide a process, mechanism or other approach, which enables multiple “run time” databases to be developed for a unique platform from a single original source database and that this process be accomplished rapidly with minimal manual interaction and without loss of geo-spatial fidelity. This

will significantly expand the utility of current rehearsal devices. Further, it will enhance the ability to rehearse the time sensitive missions by expanding the terrain available on short notice.

Technology Focus Area: Sensors
OSD98-029
Title: Examination of Emerging Haptic Tactor Technology
Objective: This effort is directed at emerging technologies that are adaptable to providing haptic cues to military personnel operating in various environmental conditions. The objective is to produce tactors with improved characteristics in the following areas: 1) miniaturization, 2) variable tactile sensor strength (frequency and amplitude modulation), 3) robustness (shock and vibration), 4) waterproofing, 5) reliability, 6) produceability, and 7) magnetic signature. A successful development program will include the achievement of the following technical objectives:

a. Demonstration of tactors that provide adequate haptic cues that are, at a minimum, twice as small as existing tactors, exhibit no (goal) electromagnetic signature, are waterproof and operational to depths of 66 fsw and altitudes to 35,000 ft., and at ambient temperatures ranging from 0˚C. to 33˚C.

b. Demonstrate reliability and durability greater than present day tactors.

Description: Tactor research is a one element of a larger program referred to as the Tactile Situation Awareness System (TSAS). The initial objective of the TSAS program was to decrease spatial disorientation accidents in the aviation community. Several studies concluded that human-factors problems accounted for the bulk of aircraft mishaps, and that spatial disorientation was the most significant human-factors problem both in terms of material and personnel losses as well as mission degradation. The 1990 Naval Research Advisory Committee Panel on Aviator Physical Stress concluded that "current displays are not adequate to prevent spatial disorientation mishaps. It is imperative that research and development be focused to ensure introduction of improved displays, controls and decision aids to reduce pilot workload." Subsequent research demonstrated that tactile displays can be an effective method of reducing or eliminating spatial disorientation, as well as providing an alternative method of receiving information from typical visual or auditory displays. This technology is now being applied to enhance navigation, communication, and warning controls and indicators for air, surface, and subsurface Special Operations missions. Another application that is under investigation is the use of tactile technology to stimulate motion sensations in non-motion based training simulators.

The principle of TSAS technology is relatively simple. Inputs provided from a source such as navigation equipment (GPS, Loran, inertial navigation systems, etc.,), gyroscopes, altimeters, accelerometers, communication devices, pressure gauges, alarms, indicators, etc., are processed by a small computer and converted into outputs that control the activation of tactors placed against the skin of an operator. The tactors provide electrical or mechanical stimulus (vibration) that is sensed by the operator. These sensations are cues for operator action. As an example, a diver receives a vibration on the left side of his/her body indicating that they are off-track of a predetermined navigation course. The diver swims in the direction of the vibration (to the left) until the vibration stops indicating they are back on course. The need for a visual display for the diver navigation has been eliminated resulting in less visual and mental workload for the diver.

A TSAS laboratory system has been developed in a collaborative effort between the Naval Aerospace Medical Research Laboratory (NAMRL), Pensacola, FL and the Coastal Systems Station (CSS), Panama City, FL. One of the many purposes of this laboratory system is to develop computer generated graphical simulations so that the feasibility of

applying tactile technology to SOF/DoD operational areas can be evaluated. Simulations of high speed surface craft navigation, underwater mine search, aircraft navigation and maneuvering, and space shuttle docking have been developed and demonstrated. Selected technologies have then been transferred from the laboratory system to operational equipment. In FY 97 TSAS technology was successfully demonstrated by hovering a UH-60 Blackhawk helicopter using tactile cues. During the same year, an underwater navigation device used by Explosive Ordnance Division divers was interfaced with a TSAS to successfully demonstrate enhanced underwater navigation using only tactile cues.

OSD98-030
Title: Small Craft Vision Enhancement/Situation Awareness System
Objective: To develop an all-weather vision enhancement system, or new components for existing systems, to support navigation of small military maritime craft (<36 ft) operating in littoral areas and extreme environments.
Description: Small military maritime craft (<36 ft) are used in low to medium threat. To facilitate all weather operations there is a need for vision enhancement systems to supplement existing navigational aids. The system(s) should integrate and fuse sensors, and processing and display elements to provide situational awareness in all types of weather, daylight, and hours of darkness. Nominal objectives are to detect a 100 ft craft at 3 miles, a 25 ft craft at 1 mile, and a navigation buoy at 1500 ft, regardless of sea-state, weather, and daylight conditions; and without increasing the craft's organic signature. Key limitations are size (less than 12 inches wide by 12 inches by 8 inches total net package size) and weight (less than 20 lbs total net package weight). Challenges include sensor mounting and operation in extreme environments, which include exposure to high g-loads and sustained vibrations, temperature and humidity extremes, and saltwater intrusion. Mounting consideration must be given to utilizing existing attachment points to include weapon mounts and display consoles. Technologies applicable to this effort include sensor fusion and image processing algorithms, high-performance and lightweight FLIR/low-light level camera systems, high performance and low power/signature displays, and stabilizing/shock mitigation packaging and mounting systems.

OSD98-031
Title: Affordable Millimeter Wave (PMMW) Electronic Technology
Objective: To demonstrate through measurement, simulation, and testing, the applicability of new PMMW millimeter wave sensor technology to diversified military aviation mission requirements, with a primary focus on affordability.
Description: The military has an inherent need to develop enabling passive as well as active sensor technology that is both affordable and flexible, with growth potential to address new requirements. Passive millimeter wave sensors are an emerging technology whose development is being facilitated by recent advances in low-noise millimeter wave components. The advantages of such sensors are that they enjoy all weather performance and are not readily detectable. PMMW sensors would inherently lower signature characteristics in an auxiliary sensor mode, and provide threat information while in an active mode. Combined with the low cost potential of evolving components, this technology offers great promise for application on aviation platforms. PMMW is envisioned as a multi-role sensor that could provide affordable all-weather navigation and reconnaissance capability and possibly communications capabilities with minimal demand for weight, space and power.

Technology Focus Area: Materials, Processes, and Structures
OSD98-032
Title: Lightweight, Portable, Blast-Resistant Barriers
Objective: To develop a barrier system, which is light, easily deployable, but made of material rugged enough to thwart a conventional blast sufficiently to protect structures.
Description: Current semi-permanent barrier systems are typically constructed of concrete or stone. These tend to be difficult to move or redeploy. Sandbags, large earth and stone mounds can be used as temporary barriers, but they provide limited protection and are time-consuming and difficult to erect. The Special Operation Force (SOF) is in need of easily deployable deflection-type barriers, which can stop and/or deflect the effects of a blast away from troops in garrison, buildings, and other structures. An "ideal" solution would be a barrier that deflects effects back to the point of origin; i.e., a car bomb explodes and the barrier sends all the debris back toward the blast or straight up in the air, away from the targeted structure. Design consideration must be given to preclude the barrier from being used to aid the explosion. The system should be employable with minimal support and material handling equipment.

U.S. Army Medical Research Acquisition Activity Topics
Technology Focus Area: Biomedical Research
The U.S. Army Medical Research Acquisition Activity has identified the following seven biomedical research topics:

OSD98-033
Title: Decontamination of Nerve Agent Exposed Personnel: Preparation of Towelettes Consisting of Immobilized Enzymes that Destroy Toxins
Objective: To develop a personal decontamination kit to remove and inactivate organophosphorous compounds from skin, wounds, or other sensitive surfaces of exposed soldiers. Such decontamination devices will also protect field medical personnel from cross-contamination and secondary contamination while attending the chemical casualties.
Description: A kit consisting of disposable towelettes similar to 2x4, 4x4, or 4x6 inch surgical pads consisting of a mixture of immobilized enzymes to destroy organophosphorous compounds is needed for personnel protection. The combination of enzymes would be cholinesterases (acetylcholinesterase/butyrylcholinesterase) and organophosphorous hydrolases from bacterial or animal origins which metabolize organophosphates (e.g. paraoxon hydrolase, phosphotriesterase, or squid diisopropylfluorophosphate hydrolase). Enzymes would be covalently linked to a matrix, like polyurethane, to form the correct texture, poracity, and consistency to function as towelettes or sponges. By crosslinking the enzymes to an immobilized support, the towelette would resist leaching of the enzyme to the skin, be stable at a wide range of temperatures, and retain enzymatic activity for a long period of storage. To increase the efficacy of such a device, an oxime would be added in the solution in which the towelette is packaged. This will ensure that the catalytic activity of organophosphate inhibited cholinesterases will be rapidly and continuously regenerated, and that the organophosphate on the skin will be detoxified.

OSD98-034
Title: Development of In Vitro Model System for Screening the Effects of Botulinum Neurotoxin
Objective: To replace the current mouse botulinum toxin neutralization assay, in whole or in part, with in vitro assay systems for determining toxin activity, antibody titers and evaluating candidate medical countermeasures.

Description: The toxin neutralization test in mice used to determine the activity of botulinum neurotoxins and neutralizing antibody in sera is cumbersome and requires a large number of laboratory animals as well as trained technical staff. Reproducibility between laboratories has also been problematic. There have been a number of alternative in vivo assays proposed. Although these may provide enhanced reproducibility and sensitivity in a given laboratory, they still suffer from the same technical constraints of the standard in vivo protocol. Although relatively sensitive Enzyme-Linked Immunosorbent Assays (ELISA) for detection of Clostridium botulinum neurotoxins and solution-phase complexes (antibody) have been developed there is a lack of definitive correlation between ELISA and biological activity of the toxin or neutralizing antibody. Ideally a motoneuron based biological system would be developed that is capable of releasing acetylcholine (Ach). This could be used as an in vitro model system for screening the effects of botulinum neurotoxins, toxin activity, toxin neutralization and candidate medical countermeasures. Similar systems have been developed to evaluate Clostridial neurotoxins and substrate proteolysis in intact neurons. These primary cell cultures do not survive for long and cannot be utilized in the screening assays. To be practical, the cell line would have to be stable for several months in culture, be well characterized, and provide reproducible responses.

OSD98-035
Title: Blood Processor for Hydroxy Ethyl Starch
Objective: To develop a medical device to process the frozen/thawed blood cryoprotectant hydroxy ethyl starch.
Description: Research and design a closed sterile filtration device to automatically thaw and wash out the frozen/thawed blood cryprotectant hydroxy ethyl starch; and add blood preservatives to attain 8 week post thaw storage. The suggested design concept is for a microprocessor-driven tabletop device with heated plates for thawing; and a peristaltic pump and valve system for processing. It should weigh less than 100 pounds, have a footprint less than 2 square feet, and a height less than 3 feet. Other design goals include: processing time less than 10 minutes; direct infusion after 8-week post thaw storage without further processing; maximum 1 liter of a single wash solution; and disposable costs less than $50. Input power should include the following multiple options: 110/220 volts AC 60 Hz; 220 volts 50 Hz (European power); commercial or generator driven tactical sources. The device should be universal and flexible so that it can be adapted for other blood processing procedures.

OSD98-036
Title: Development of Temperature and Humidity Insensitive Dental Materials
Objective: To develop, test, and deploy polymeric based dental materials that are temperature and humidity insensitive for use under deployed conditions.
Description: Current polymeric dental materials, both those used as a portion of a composite restorative system and those used as impression materials, are prone to unpredictable physical properties when used outside controlled environmental conditions. Extremes in temperature and high humidity cause deterioration of most desirable properties. Storage histories of these materials also adversely effect physical properties. Development of temperature and humidity insensitive dental materials would allow much more predictable results in deployed situations. It would also permit relaxed handling and storage of these materials.

OSD98-037
Title: Head Motion Tracking and Performance Measurement of Helicopter Pilots During Simulated Flights Over Digitized Terrain
Objective: To develop and build a PC-based virtual reality projection software and hardware system which can be easily programmed, maintained and operated by the user.

The system will be used in various laboratory settings, including the study of the effects of head-supported devices on the performance of helicopters pilots during simulated terrain fly-over and while exposed to whole-body vibration.
Description: An important function of helmets worn by helicopter pilots is its use as a platform to mount an array of devices that enhance the pilot's performance. The weights of these helmet-mounted devices (HMD) have increased as they became more complex and as new capabilities are introduced. The effects of the added weight on pilot fatigue and performance is evaluated in a laboratory setting prior to final fielding. Because of whole-body vibration and the HMD added weight, the accuracy of tracking a moving target is likely to degrade. With recent proliferation of virtual reality (VR) software and hardware, the accuracy of target tracking can be measured using inexpensive computer platforms and drawing upon public domain terrain data, open architecture graphic software and lightweight tracking hardware. Many components of the desired system have been demonstrated to work in commercial, shareware and freeware video game and research products on inexpensive personal computer platform, i.e., they do not require expensive graphic workstation hardware and software. These include: 3-D motion tracking devices that monitor the head motion; terrain simulation based on published terrain elevation satellite data; interactive terrain fly-over that simulates the view from the cockpit as the pilot maneuvers the helicopter; real-time display of instruments and symbols to reflect pilot's actions; the ability to control and pre-program the mission profile; and monitoring and scoring of pilot's tracking actions. Since the system will be used for evaluation of HMDs, VR goggles and similar head-worn devices cannot be used. Instead, VR imagery must be projected on one or multiple screens as necessary. The desired system is not intended as a training platform but as an inexpensive research tool that can be easily modified and maintained as new technologies or research requirements emerge.

OSD98-038
Title: Development of a Catalytically Reactive Topical Skin Protectant (rTSP) Against Chemical Warfare Agents
Objective: To identify and synthesize catalytically reactive materials capable of neutralizing chemical warfare agents (CWAs), vesicants, and/or nerve agents when incorporated into a cream of perfluorinated polyether oil thickened with polytetrafluoroethylene, that can be applied to the skin as a protectant from cutaneous exposure to CWAs.
Description: There is a requirement to develop catalytic materials capable of neutralizing CWAs that contact the skin. These materials must prevent the toxic effects of skin contact with CWAs when the catalyst is incorporated into a cream of perfluorinated polyether oil thickened with polytetrafluoroethylene. This cream has already been demonstrated to provide a physical barrier against CWAs. The incorporated catalysts must enhance the barrier effect of the cream by chemically neutralizing the CWAs, so that in case of barrier breakdown the agent is no longer toxic. The material should have reasonable cost, be safe and nonirritating, be chemically stable, and demonstrate rapid kinetics. Successful proposals must possess a viable concept, an evaluation plan demonstrating a logical sequence of steps to identify, synthesize and test the catalytic materials for preparation of the final product.

OSD98-039
Title: Detection of Persons with Mild, Intermittent Asthma
Objective: To develop a rapid, inexpensive method to screen all military recruit applicants for asthma, particularly those with mild or moderate disease. Results should be standardized and easily interpretable by physicians without specialty training in pulmonary medicine. The screening test should be sensitive, specific, and without significant health risk to persons tested.

Naval Sea Systems Command Topics
Technology Focus Area: Materials Process Technology Area

OSD98-040
Title: Fire Resistant Organic Composite Material
Objective: To develop a low cost organic composite resin material which meets the fire and toxicity requirements of MIL-STD 2031, possesses mechanical properties similar to standard vinylester and polyester resins, and can be processed using a vacuum-assisted resin transfer molding (VARTM) process and low-temperature cure.
Description: The low cost organic composite resin material should be <$10/lb and be resistant to structural degradation and toxic off-gassing when subjected to a severe fire insult. This resin system must have a viscosity suitable for VARTM fabrication, a cure temperature less than 160˚F, and maintain mechanical properties at operating temperatures of 200˚F.

OSD98-041
Title: Superelastic Shape Memory Alloy (SMA) for Seal Applications
Objective: To develop robust, corrosion free and long life sealing technology utilizing a superelastic shape memory alloy made by either plasma spraying or other near net shape processes.
Description: Recent advances in the plasma spraying of conventional SMA have indicated that this process could be modified to produce superelastic SMA material. This superelastic material could be used to solve the long standing Naval problem of reliably preventing green water and other fluids or air-born contaminates from entering a vessel. Future surface ships will require advanced hatch and hanger door seals. SMA seals would have the advantage of being non-pyrolytic, large strain (more sealing force), tough, non-corrosive and Radar Cross Section (RCS) compliant. Challenges include adapting the processing techniques to produce superelastic material in sufficient lengths and thickness in near net shape.

OSD98-042
Title: Development of a Self-Cleaning Filter System for Navy Shipboard Reverse Osmosis Application
Objective: To develop a small/lightweight self-cleaning filtration system for shipboard Reverse Osmosis (RO) desalination plants to enable operation in port and other areas close to shore.
Description: The Navy is presently developing a RO desalination plant for aircraft carrier application. The major problem foreseen with the operation of such a plant is when the ship is operating in coastal areas and in the open ocean where large quantities of colloidal solids and plankton/small animal matter occasionally exist. High concentrations of colloidal solids and plankton/small animal matter in the seawater feed stream to the RO system have been found to plug and blind strainers and filters on Navy surface ships (such as destroyers), virtually disabling the filtration system from operating. The typical solution to this problem often proposed by commercial vendors is to use large multimedia filters (volumes in excess of 750 cu. ft. and weights above 25,000 lbs.) to remove these foulants from the 300 to 400 gal/min feed seawater stream. Filtration systems of this size and weight are unacceptable for Navy shipboard application. Therefore, a small lightweight self-cleaning/back-flushable filter is sought for shipboard RO application.

OSD98-043
Title: High Temperature Multifunctional Core Material for Lightweight Composite Structures
Objective: To develop structural core material, which can be used with composite material processing as a fire barrier system and can provide multifunctional capability to the composite section.
Description: Composite materials are currently being investigated for use as the structural material for topside structures as well as other Naval applications. Low cost composite processing materials such as glass/vinylester composites are the material of choice. Solid cores (balsa) and foam cores (pvc, urethane, etc.) have been considered. These core materials have high temperature performance limitations. A core material which could maintain structural integrity after the UL 1709 fire testing is the goal for the core material. In addition, incorporation of various signature characteristics is desired, such as Radar Cross Section (RCS) control, electromagnetic interference (EMI) shielding, and frequency selective surfaces for antenna concerns. These characteristics, for example, were incorporated in the Advanced Enclosed Mast/Sensor System (AEM/S). The core material should be compatible with vacuum assisted resin transfer molding (VARTM) type processing and should be environmentally stable in the temperature range of -60 to 180˚F, not be degraded by water and be capable of surviving 30 year service life. Large quantity acquisition costs should be comparable to that of high temperature foam, e.g. pvc foam ($16/board foot).

OSD98-044
Title: Lightning Protection for Ship Topsides Fabricated of Composite Materials
Objective: To develop, demonstrate and document an effective, low signature, low cost, lightning protection system for topsides of ships that are fabricated of non-metallic materials.
Description: The lightning protection system must be capable of providing sufficient protection against lightning strikes in a natural environment as specified in MIL-STD 464.